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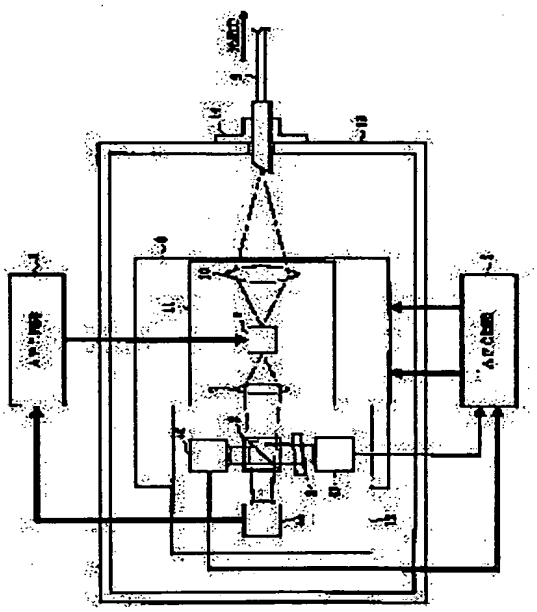
(54) LASER DIODE MODULE

(57)Abstract:
PROBLEM TO BE SOLVED: To easily improve wavelength stability by adjusting the temperature of a laser diode, controlling the transmission wavelength and bringing the laser diode and an optical wavelength filter into thermal contact so as to keep both at an almost equal temperature.
SOLUTION: A laser diode 1 inside a module package outputs the laser beam of a prescribed transmission wavelength and an optical fiber 9 is optically coupled to the laser diode 1 and leads out the laser beam outputted from the laser diode 1 to the outside. An optical wavelength filter 3 is provided with a cut-off wavelength almost same as the transmission wavelength of the laser diode 1. One or more photodiodes for wavelength control transmits or reflects a part of the light output of the laser diode 1 to the optical wavelength filter, then, receives it and outputs the received light level. Then, a Peltier element 6 controls the transmission wavelength of the laser diode 1. Further, a thermal contact means brings the laser diode 1 and the optical wavelength filter 3 into thermal contact so as to keep both at the almost same temperature.



LEGAL STATUS

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CLAIMS

[Claim(s)]
[Claim 1] The laser diode which outputs the laser beam of predetermined oscillation wavelength in a module package, The optical fiber which derives outside the laser beam which optical combination was carried out and was outputted to this laser diode from the laser diode, The light wave length VCF with the oscillation wavelength of a laser diode, and the almost same cut-off wavelength, One or more photo diodes for a wavelength control which receive light after making a light wave length VCF penetrate or reflect a part of optical output of a laser diode, and output the light-receiving level, The laser diode module characterized by having the ******** element which controls the oscillation wavelength of a laser diode by adjusting the temperature of a laser diode, and a heat contact means to carry out the heat contact of both so that a laser diode and a light wave length VCF may be kept almost isothermal.
[Claim 2] The laser diode which outputs the laser beam of predetermined oscillation wavelength in a module package, The optical fiber which derives outside the laser beam which optical combination was carried out and was outputted to this laser diode from the laser diode, The light wave length VCF with the oscillation wavelength of a laser diode, and the almost same cut-off wavelength, The beam splitter which carries out the spectrum of a part of optical output of a laser diode to two, the spectrum of this beam splitter — light being received after making a light wave length VCF penetrate or reflect one side of an output, and with one or more photo diodes for a wavelength control which output the light-receiving level The photo diode for power monitors which receives another side of the part optical output of a beam splitter, and outputs the light-receiving level, The laser diode module characterized by having the ******** element which controls the oscillation wavelength of a laser diode by adjusting the temperature of a laser diode, and a heat contact means to carry out the heat contact of both so that a laser diode and a light wave length VCF may be kept almost isothermal.
[Claim 3] It is the laser diode module characterized by for a heat contact means carrying beforehand a light wave length VCF, each photo diode, and a beam splitter in a laser diode module according to claim 2, carrying out position doubling to a laser diode so that the light-receiving level of the photo diode for power monitors may serve as the maximum, and being fixed by YAG laser welding.
[Claim 4] It is the laser diode module characterized by for a heat contact means carrying each photo diode and a beam splitter beforehand, carrying out position doubling, fixing in a laser diode module according to claim 2 so that the light-receiving level of the photo diode for power monitors may serve as the maximum, being fixed by YAG laser welding, and fixing the light wave length VCF to the heat contact means after fixation by YAG laser welding so that the light-receiving level of the photo diode for a wavelength control may serve as a predetermined value.
[Claim 5] It is the laser diode module characterized by a heat contact means consisting of a metal substrate with low thermal conductivity in a laser diode module according to claim 1 to 4.
[Claim 6] The laser diode module characterized by the light wave length VCF and the beam splitter being constituted by one in a laser diode module according to claim 1 to 5.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] Especially this invention is the laser diode light source module used for optical communication or instrumentation about a laser diode module, and relates to the laser diode module used when a precise wavelength precision is demanded especially.
[0002]
[Description of the Prior Art] In recent years, in connection with development of wavelength multiplex transmission technique, the wavelength (frequency) precision in 0.1nm order came to be demanded, and since wavelength variation accompanied by the aging of an element etc. cannot be compensated only with control of using DFB-LD (Distributed Feed Back-LaserDiode) with constant temperature simply, precision came to run short by it. As LD light source which carried out the wavelength control with high precision conventionally, as shown in drawing 6 , there is a configuration locked on specific wavelength using a fiber grating.
[0003] As for an optical turnout and 63, in this drawing, LD module with which 61 built in the temperature-control element, and 62 are [a fiber grating and 64] PD (Photo Diode) module and a thermostat for [65] fiber gratings in an automatic-frequency-control (AFC) circuit and 66. In this case, since a part of output light of the LD module 61 is introduced into a fiber grating by the optical turnout 62 and the reflected light takes peak value to specific wavelength, the PD module 64 detects this and stabilization of oscillation wavelength is performed by feeding back to LD temperature of the LD module 61 by AFC circuit 65.
[0004] However, since wavelength except the wavelength set up first cannot be arbitrarily taken out with this configuration, in order to take out much wavelength with wavelength multiplex etc., the fiber grating which doubled and manufactured [each] wavelength only precisely on wavelength is needed. Furthermore, since there was temperature dependence of about 0.005nm/degree C although it was called the fiber grating in order to acquire the wavelength stability of 0.1nm or less by large operating temperature limits called 0-60 degrees C, temperature stabilization was needed, and there was a problem that a configuration became complicated.
[0005] There is also a configuration which adjusts the temperature and the drive current of LD so that the ratio of through, its transparency power, and reflective power may become fixed in a part of output light of LD on the other hand at a light wave length VCF using the steep cut-off field of the light wave length VCF using the dielectric multilayer, as shown in drawing 7 . LD module with which 71 built in the temperature-control element in this drawing, and 72 — for PD module and 75, as for the thermostat of light wave length VCF 73, and 77, an AFC circuit and 76 are [a beam splitter and 73 / a light wave length VCF and 74 / ********** optical system and 78] the incident angle controlling mechanisms of light wave length VCF 73 ——— collimate
[0006] In this case, after collimating the output light of the LD module 71 with the ********** optical system 77, Since the part is taken out by the beam splitter 72, it introduces into light wave length VCF 73 and the transparency power (used by carrying out reflective power, transparency, and reflex to a differential) changes sensitively depending on wavelength The PD module 74 detected it, by AFC circuit 75, LD temperature of the LD module 71 was adjusted and oscillation wavelength was stabilized.
[0007] In addition, light wave length VCF 73 used here is not cared about, even if a bypass or low-pass one are a band pass filter again, since a cut-off field is only used. By changing the incident angle of a VCF mechanically with the incident angle controlling mechanism 78, using the effect that center of filter wavelength shifts, the wide range wavelength tuning is possible with one kind of VCF, and it has electrically the advantage that fine ** of wavelength is also possible, by choosing the power ratio of transparency (reflex) further with this configuration.
[0008]
[Problem(s) to be Solved by the Invention] However, by such conventional laser diode module, there was a trouble where it will be dependent on the stability of the light wave length VCF with which wavelength precision used the dielectric multilayer, and a temperature control became indispensable to a large operating temperature limits since it has the temperature coefficient of a fiber grating and this level also for a light wave length VCF. Moreover, since it consisted of a respectively individual module, the space factor was bad and optical system also had the trouble of having become complicated and becoming a high cost. this invention is for solving such a technical probrem, and moreover it is compact at a low cost, and aims at offering the laser diode module with a sufficient wavelength stability.
[0009]
[Means for Solving the Problem] In order to attain such a purpose, the laser diode module by this invention The laser diode which outputs the laser beam of predetermined oscillation wavelength in a module package, The optical fiber which derives outside the laser beam which optical combination was carried out and was outputted to this laser diode from the laser diode, The light wave length VCF with the oscillation wavelength of a laser diode, and the almost same cut-off wavelength, One or more photo diodes for a wavelength control which receive light after making a light wave length VCF penetrate or reflect a part of optical output of a laser diode, and output the light-receiving level, It has the ******** element which controls the oscillation wavelength of a laser diode, and a heat contact means to carry out the heat contact of both so that a laser diode and a light wave length VCF may be kept almost isothermal, by adjusting the temperature of a laser diode. Therefore, a light wave length VCF becomes almost isothermal with the laser diode in which a temperature control is carried out almost uniformly by the ******** element, and temperature stabilization is carried out.
[0010]
[Embodiments of the Invention] Next, this invention is explained with reference to a drawing. Drawing 1 is a block diagram showing the laser diode module which is the gestalt of operation of the 1st of this invention. In this drawing, the light wave length VCF with which in 1 LD (Laser Diode) element and 2 used the optical beam splitter, and 3 used the dielectric multilayer, and 4A, 4B and 4C are PD carriers which carried PD (Photo Diode) element in the end face.
[0011] Moreover, the lens for combining with an optical fiber the lens for the ******** element for which 5 performs an AFC circuit and 6 performs the temperature control of LD, and 7 converging the rear-face light of LD, and 9, and 10 combining a front

light of LD with an optical fiber 9, LD carrier in which 11 carried LD, and 12 are the metal substrate in which light wav length VCF 3 and the PD carriers 4A-4C were carried, and a sleeve for [13] fiber hold fixation in LD module package
[0012] It converges with a lens 7, LD rear-face output light is divided into the object for power monitors, and a wavelength control by the beam splitter 2, and PD of each PD carriers 4A-4C is made to receive light with the gestalt of this operation. In drawing 1 , they are PD carrier for power monitors in 4A, and PD carrier for a wavelength control in 4B and 4C. PD carrier 4C is put on the position which the light reflected with light wave length VCF 3 penetrates a beam splitter 2, and can receive.
[0013] In order to assemble this, the LD element 1 is first carried in the LD carrier 11, and a lens 10 is fixed to the LD carrier 11 by YAG laser welding. The ******** element 6 and the LD carrier 11 are fixed with a pewter in LD module package after that, and a fiber 9 is aligned in a optimum coupling position through a sleeve, and it fixes by YAG laser welding.
[0014] Next, a lens 7 is fixed to the LD carrier 11 with YAG welding, a low-temperature pewter, or adhesives, and, on the other hand, the PD carriers 4A-4C, light wave length VCF 3, and the beam splitter 2 are fixed to the metal substrate 12 with a pewter or adhesives. And the LD element 1 is made to emit light, after connecting with a package terminal with a longer golden wire, and when the light-receiving current of the PD carriers for a wavelength control 4B and 4C is the wavelength of choice, the angle and position of the metal substrate 12 to the LD carrier 11 are adjusted, and it fixes by the YAG laser from the upper part so that the light-receiving current of PD carrier 4A for power monitors may become as large as possible almost equally.
[0015] Although the precision prescribe (tolerance) at the time of this fixation is mainly dependent on the light-receiving area of PD, since large area PD for low speeds can be used, a tolerance is loose and the axial gap at the time of YAG welding is satisfactory here. Here, since a temperature change will become loose when the weldability in an YAG laser changes momentarily [the temperature of the LD element 1] in the noise of a circuit etc. well if the metal substrate 12 is made into the material with the low thermal conductivity of stainless steel etc., there is an advantage that the tolerance to a noise becomes large.
[0016] The temperature dependence coefficient of the light wave length VCF using the dielectric multilayer fundamentally is the parvus farther than LD (it is about 0.1nm/degree C at usual DFB-LD). Therefore, since constant temperature is stable in the long run even if it is not necessary to carry out a temperature control so precisely and at high speed and thermal conductivity is somewhat low, it is enough.
[0017] With the gestalt of this operation, when temperature is changed, in order to make the automatic power adjustment (APC) circuit for keeping output power constant become independent, PD for power monitors (PD carrier 4A) is prepared in exclusive use. However, if the circuit of APC and AFC is devised and it unifies, it is also possible to carry out APC control with the light-receiving current of PD for a wavelength control (PD carriers 4B and 4C).
[0018] There is an advantage which is corrected, and the light-receiving current ratio of two PDs for a wavelength control in this (PD carriers 4B and 4C) can use as a common ordinary LD module in usual APC circuit when [which is because the light-receiving current which flows then is proportional to power if decided uniformly] not using AFC circuit 5 with the gestalt of this operation. Moreover, the fixed means or assembly sequence of each part article do not need to adhere to the above-mentioned description, and may be changed according to equipment, the conditions of a member, etc.
[0019] Furthermore, although drawn on the position which each PD carrier turns to at right angles to an incident light in drawing 1 , in order to avoid that the reflected light returns to LD in fact, it cannot be overemphasized that it is better for an optical axis and an end face to have arranged so that an angle may be attached slightly.
[0020] Next, with reference to drawing 2 , the gestalt of operation of the 2nd of this invention is explained. Drawing 2 is a block diagram showing the laser diode module which is the gestalt of the 2nd operation. In this drawing, or it is the same as that of the above-mentioned (refer to the drawing 1), the same sign is given to the equivalent fraction and 5A is the control circuit of AFC / APC combination.
[0021] It is the characteristic feature that the breadth of the module package 13 can be slimmed by placing light wave length VCF 3 in the orientation of an optical axis of the LD element 1 at the same time it sets the gestalt of this operation to one and it simplifies PD for a wavelength control. Although the assembly technique is the same as that of the gestalt of the 1st operation almost, since PD for a wavelength control is only PD carrier 4B, a light-receiving current is fixed in the neighborhood of maximum set to 2 about 1/at the time of convention wavelength.
[0022] With the structure where LD carrier temperature is change of at most less than 5 degrees C, and temperature stabilization of light wave length VCF 3 and the PD for a wavelength control is carried out in the time of real use, at least one of the two's PD is [but] possible for stabilization enough. However, in order to control AFC circuit 5A so that the current ratio of PD for monitors and PD for a wavelength control becomes fixed, and to also carry out APC operation simultaneously, it makes LD drive circuit for APC built in AFC circuit 5A.
[0023] Next, with reference to drawing 3 , the gestalt of operation of the 3rd of this invention is explained. Drawing 3 is a block diagram showing the laser diode module which is the gestalt of the 3rd operation. In this drawing, it is the same as that of the above-mentioned (drawing 1 , two references), or the same sign is given to the equivalent fraction.
[0024] With the gestalt of this operation, simplification of assembly is attained by sticking a beam splitter 2 and light wave length VCF 3, or unifying by double-sided vacuum evaporationo. On arrangement of the PD carriers 4A and 4B, although the layer design doubled with it is required in order to have to enlarge the incident angle of light wave length VCF 3 **, it is fundamentally satisfactory, and the assembly technique and operation are almost the same as that of the gestalt of the 2nd operation, and an explanation here is omitted.
[0025] Next, with reference to drawing 4 , the gestalt of operation of the 4th of this invention is explained. Drawing 4 is a block diagram showing the laser diode module which is the gestalt of the 4th operation. In this drawing, or it is the same as that of the above-mentioned (refer to the drawing 1 -3), the same sign is given to the equivalent fraction and 15 is 1/2 wavelength plate.
[0026] With the gestalt of this operation, the enhancement in detection sensitivity is measured by using an ordinary glass plate as a beam splitter 2 using the difference of the reflection factor of the polarization component to an incident angle. Here, if it is 56.5 incident angles (brewster's angle), using BK7 (refractive-index =1.51) as a glass plate, on the other hand, the reflection factor to polarization of an parallel component will almost become 0% to vertical-component light about 15% to plane of incidence.
[0027] Since the LD element 1 is usually a TE-mode oscillation (if it is arrangement of drawing 4 incident angle perpendicular polarization), if it puts in 1/2 wavelength plate 15 between beam splitters 2 and rotates this 90 degrees, since TM component (spontaneous-emission light containing a mainly large wavelength component) of the LD element 1 does not come to wavelength detection PD, it has the advantage that the noise level of a wavelength detection can be reduced.
[0028] In addition, in fact, even if the incident angle of a glass plate has the error of about **5 times, it is effective in the polarization separation enough, and it is satisfactory also to the angle adjustment at the time of wavelength doubling. Except having added 1/2 wavelength plate 15, the assembly technique and operation are almost the same as that of the gestalt of the 2nd operation, and an explanation here is omitted.
[0029] Next, with reference to drawing 5 , the gestalt of operation of the 5th of this invention is explained. Drawing 5 is a block diagram showing the laser diode module which is the gestalt of the 5th operation. In this drawing, or it is the same as that of the above-mentioned (refer to the drawing 1 -4), the same sign is given to the equivalent fraction and 3A is the light wave length

VCF beforehand fixed to the metal member.
[0030] Although the gestalt of this operation is the same configuration as optically as the gestalt of the 2nd operation, it changes an assembly procedure. That is, it aligns and YAG fixation of the metal substrate 12 in which the beam splitter and PD were carried beforehand is carried out so that the light-receiving current of each PD (PD carriers 4A and 4B) may become the maximum to the LD carrier 11.
[0031] And finally, light wave length VCF 3 is position(mainly angle)-set, and is carried out, YAG fixation of the metal section is carried out, and it is assembled in the place where the light-receiving current of PD for a wavelength control (PD carrier 4B) becomes the half grade of maximum. According to such assembly technique, although a man day increases, since it can ease, the precision of each part article can expect the enhancement in the yield, and an optimization of a property.
[0032] In addition, in the gestalt of each operation explained above, although the rear-face light of the LD element 1 was chiefly used for the wavelength detection, if a certain amount of power loss is allowed, it is also possible to take out and use a part of front outgoing-radiation light of the LD element 1 by the one-way mirror etc.
[0033]
[Effect of the Invention] The laser diode by which this invention outputs the laser beam of predetermined oscillation wavelength in a module package as explained above, The optical fiber which derives outside the laser beam which optical combination was carried out and was outputted to this laser diode from the laser diode, The light wave length VCF with the oscillation wavelength of a laser diode, and the almost same cut-off wavelength, One or more photo diodes for a wavelength control which receive light after making a light wave length VCF penetrate or reflect a part of optical output of a laser diode, and output the light-receiving level, It has the ******** element which controls the oscillation wavelength of a laser diode, and a heat contact means to carry out the heat contact of both so that a laser diode and a light wave length VCF may be kept almost isothermal, by adjusting the temperature of a laser diode. Therefore, a light wave length VCF becomes almost isothermal with the laser diode in which a temperature control is carried out almost uniformly by the ******** element, and since temperature stabilization is carried out, a single module can realize the laser diode light source with the outstanding wavelength stability to a compact and a low cost like before, without preparing a thermostat separately.

[Translation done.]

* NOTICES *

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the block diagram showing the laser diode module by the gestalt of the 1st operation.
[Drawing 2] It is the block diagram showing the laser diode module by the gestalt of the 2nd operation.
[Drawing 3] It is the block diagram showing the laser diode module by the gestalt of the 3rd operation.
[Drawing 4] It is the block diagram showing the laser diode module by the gestalt of the 4th operation.
[Drawing 5] It is the block diagram showing the laser diode module by the gestalt of the 5th operation.
[Drawing 6] It is the block diagram showing the conventional laser diode module.
[Drawing 7] It is the block diagram showing other conventional laser diode modules.
[Description of Notations]
1 [— A light wave length VCF 4A / — PD carrier (for power monitors),] — LD element, 2 — A beam splitter, 3 4B, 4C [— AFC / APC circuit,] — PD carrier (for a wavelength control), 5 — An AFC circuit, 5A 6 [— An optical fiber, 10 / — A lens (for front light), 11 / — LD carrier, 12 / — A metal substrate, 13 / — A module package, 14 / — A sleeve, 15 / — 1/2 wavelength plate.] — A ******** element, 7 — A lens (for rear-face light), 9

[Translation done.]

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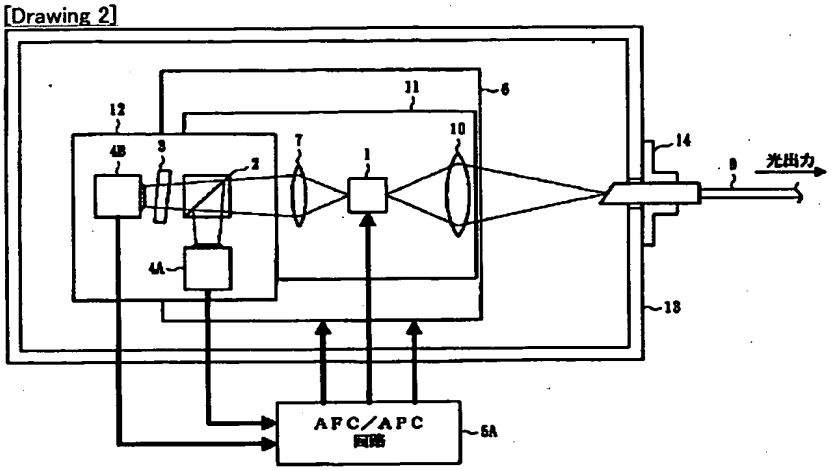
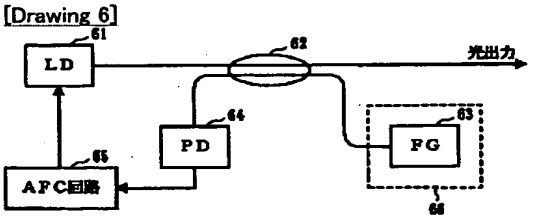
DRAWINGS

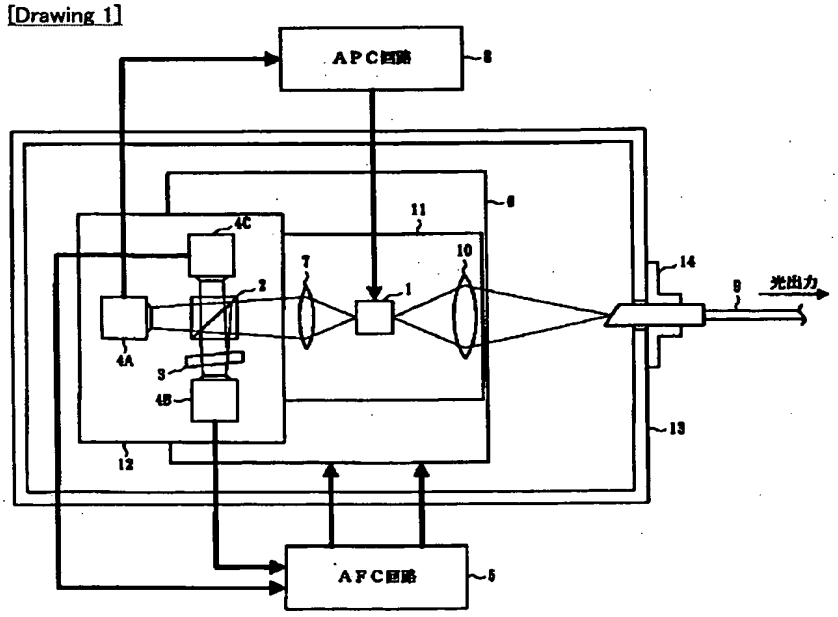
[Drawing 2]



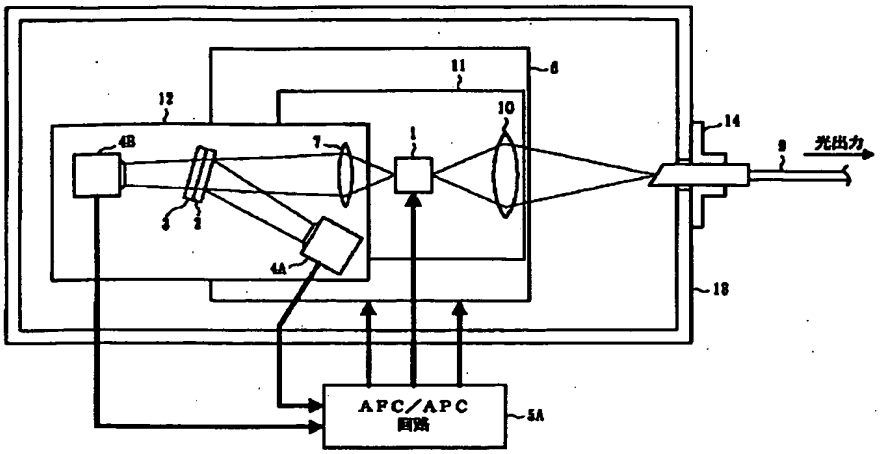
[Drawing 6]



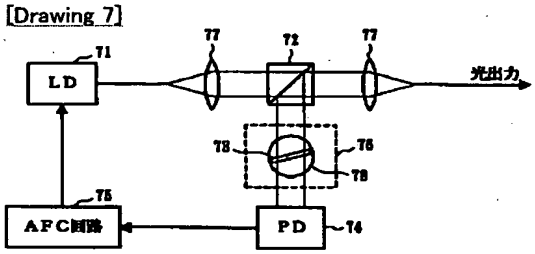
[Drawing 1]



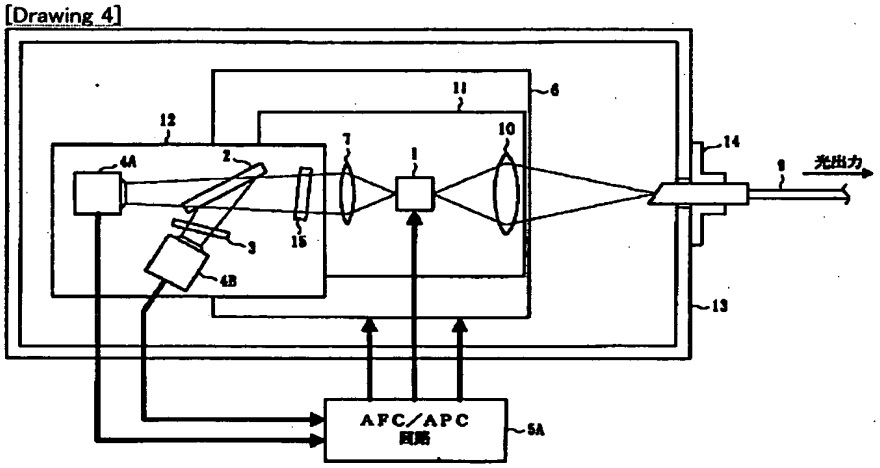
[Drawing 3]



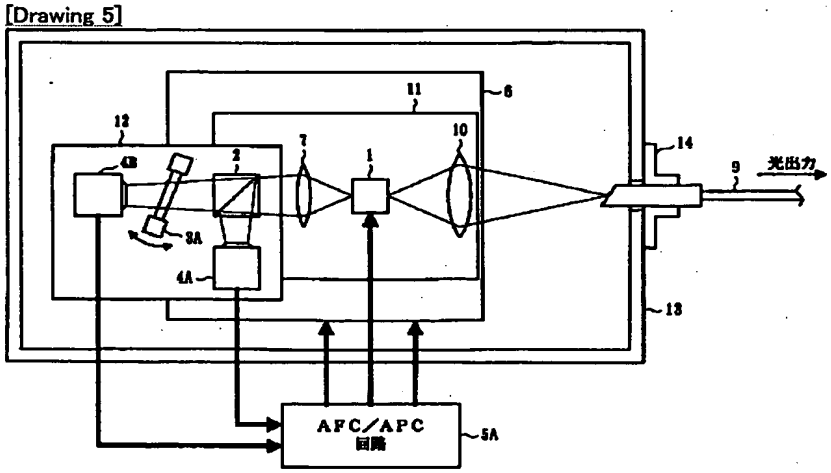
[Drawing 7]



[Drawing 4]



[Drawing 5]



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